REMARKS

I. Introduction

Claims 1, and 4-11 are pending in the above application.

Claims 2 and 3 have been cancelled without prejudice or disclaimer.

Claims 1, 4 and 8-10 stand rejected under 35 U.S.C. § 102.

Claims 5-7 stand rejected under 35 U.S.C. § 103.

Claim 11 is newly added.

Claim 1 is the only independent claim under review.

II. Amendments

Claims 2 and 3 have been cancelled without prejudice or disclaimer.

Claims 1, 5 and 9 have been amended to clarify the invention recited therein. No new matter has been added.

III. Prior Art Rejections

A. Claims 1, 4, 8, 9 and 10 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Kondo (U.S. Pat. No. 6,388,307) as set forth on pages 2-4 of the Office action.

Anticipation under 35 U.S.C. § 102 requires that each and every element of the claim be disclosed in a prior art reference as arranged in the claim. See, C.R. Bard, Inc. v. M3 Sys., Inc., 157 F.3d 1340, 1349, 48 U.S.P.Q.2D (BNA) 1225 (Fed. Cir. 1998); and Connell v. Sears, Roebuck & Co., 220 USPQ 193, 198 (Fed. Cir. 1983).

Kondo does not disclose a semiconductor device in which a band gap in the upper layer of the second semiconductor layer decreases gradually in a direction from the emitter region

toward the collector region, and the impurity concentration in the upper layer is substantially constant, as recited by amended claim 1. Kondo teaches, as shown in Fig.9, that the Ge content of the SiGe-HBT is uniform at about 20% in the B-doped (boron-doped) region and the emitter-base junction region adjacent therewith, and has a substantially trapezoidal profile with the maximum value of about 35% in the base-collector junction region adjacent to the B-doped region. Moreover, the B peak concentration in the base layer is about 1×10^{20} cm^{-3}. Since the Ge concentration in the upper layer of the second semiconductor layer in Kondo is constant, the bandgap is also constant, and the boron concentration in the upper layer decreases abruptly in the direction from the collector region (1×10^{20}) towards the emitter region (1×10^{16}).

On the other hand, according to the present invention, the band in the upper layer of the second semiconductor layer decreases gradually in the direction from the emitter region towards the collector region, it is not constant. Moreover, the impurity concentration in the upper layer is substantially constant (see Fig.3). Therefore, the bandgap and the impurity concentration in the upper layer of the second semiconductor layer in the present invention are different from those in Kondo.

Hence, as Kondo does not disclose each and every element of amended claim 1, Kondo does not anticipate amended claim 1, nor dependent claims 4 and 8-10 which depend on amended claim 1 and contain all the limitations therein.

B. Claims 5 and 6 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kondo in view of Crabbe et al. (U.S. Pat. No. 5,352,912) (hereafter "Crab") as set forth on pages 4-5 of the Office action.

Obviousness can only be established by combining or modifying the teachings of the prior art to produce the ***claimed invention*** where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. Ecolochem Inc. v. Southern California Edison Co., 227 F.3rd 1361, 56 U.S.P.Q.2d (BNA) 1065 (Fed. Cir. 2000); In re Dembiczak, 175 F.3d 994, 999, 50 U.S.P.Q.2D (BNA) 1614, 1617 (Fed. Cir. 1999); In re Fine, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988); In re Jones, 958 F.2d 347, 21 U.S.P.Q.2d 1941 (Fed. Cir. 1992). See also MPEP 2143.01.

Further, a prior art reference must be considered as a whole, including portions that teach away from the claimed invention. A teaching away rebuts a conclusion of obviousness. See, W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 220 USPQ 303, see also MPEP 2141.02, sixth heading.

Neither Kondo nor Crabbe, taken alone or in combination, disclose or suggest the claimed invention set forth in claims 5 and 6 which incorporate amended claim 1 by being dependent thereon. As described above, Kondo does not disclose all the elements of amended claim 1. Crabbe does not make up the deficiencies of Kondo. Accordingly, the combination of Kondo and Crabbe does not render claims 5 and 6 unpatentable.

Furthermore, Kondo teaches away from being combined with Crabbe. According to Kondo, as shown in Fig. 15, as the Ge content increases, the B diffusion coefficient decreases to lower the diffusion speed. If the Ge content is increased in a region adjacent to the B-doped layer of the base, since the diffusion speed of B in the portion is lowered, widening of the width in the depth profile of B can be suppressed. Crabbe teaches, as shown in Fig.2, the grading profile of Ge in the base region increases from the emitter side of 5% to the collector side of

23%. However, since the Ge concentration in Kondo is increased to more than 20% in order to suppress the widening of the width of boron distribution, Kondo teaches away from Crabbe, in which the Ge concentration in the upper layer of the base layer is reduced to 5% in order to suppress the widening of the width of boron distribution. Hence, Kondo cannot be combined with Crabbe.

C. Claim 7 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kondo in view of Croke III (U.S. Pat. No. 6,316,795) (hereafter "Croke") as set forth on pages 5-6 of the Office action.

Neither Kondo nor Croke, taken alone or in combination, disclose or suggest the claimed invention set forth in claim 7 which incorporates amended claim 1 by being dependent thereon. As described above, Kondo does not disclose all the elements of amended claim 1. Croke does not make up the deficiencies of Kondo. Croke teaches, as shown in Fig. lb, a base layer of SiGe including carbon. Accordingly, the combination of Kondo and Croke does not render claim 7 unpatentable.

IV. New Claim 11

New claim 11 is dependent on independent claim 1, and hence is patentable at least for the same reasons as claim 1.

V. Conclusion

Applicant respectfully submits that the application is in condition for allowance, an early indication thereof is respectfully solicited. Should the Examiner have any questions or concerns

regarding the amendments presented herein, the Examiner is invited to contact the undersigned representative of the Applicant.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY

Lawrence Cullen
Registration No. 44,489

600 13th Street, N.W.
Washington, DC 20005-3096
(202)756-8000
Facsimile: (202)756-8087
Date: June 13, 2003

APPENDIX

IN THE CLAIMS:

Please cancel claims 2, 3 and 11 without prejudice or disclaimer.

Please amend claims 1, 5 and 9 and add new claim 11 as follows:

1. (Amended) A semiconductor device, comprising:

a substrate having a first semiconductor layer;

a second semiconductor layer provided on the first semiconductor layer, wherein the second semiconductor layer has a smaller band gap than the first semiconductor layer and is made of a mixed crystal semiconductor; and

a third semiconductor layer, which is provided on the second semiconductor layer and has a larger band gap than the second semiconductor layer;

wherein the semiconductor device functions as a heterojunction bipolar transistor in which at least a portion of the first semiconductor layer is a collector region including first conductive-type impurities; at least a portion of the second semiconductor layer is a base region including second conductive-type impurities; and at least a portion of the third semiconductor layer is an emitter region including the first conductive-type impurities;

wherein the second semiconductor layer comprises a graded composition layer having a composition in which the band gap becomes larger in a direction from the collector region toward the emitter region, and a upper layer having a composition in which the band gap change ratio is smaller than the band gap change ratio of the graded composition layer;

a band gap in the upper layer of the second semiconductor layer decreases gradually in a direction from the emitter region toward the collector region, and the impurity concentration in the upper layer is substantially constant, and

an emitter-base junction is formed in the upper layer of the second semiconductor layer.

5. (Amended) The semiconductor device according to claim [4] 1, wherein

the second semiconductor layer is a SiGe layer;

the third semiconductor layer is a Si layer; and

the Ge content in the upper layer of the second semiconductor layer [is in a range of 2 to 8%, and] changes not more than 4%.

9. (Amended) The semiconductor device according to claim 1, wherein the impurity concentration in the graded composition layer of the second semiconductor layer decreases as the band gap increases in the direction from the collector region toward to the emitter region[, and the impurity concentration in the upper layer of the second semiconductor layer is substantially constant].

11. (New) The semiconductor device according to claim 1, wherein

the second semiconductor layer is a SiGe layer;

the Ge content in the upper layer of the second semiconductor layer is not constant, and gradually increases in the direction from the emitter region toward the collector region; and

the Ge content in the graded composition layer of the second semiconductor layer increases in the direction from the collector region toward the emitter region.